

## CLAIMS:

1. A method for the manufacture of ammonium nitrate and LDH containing nitrate as an interlayer anion, the method including the steps of:

- (1) providing a source of nitric acid
- 5 (2) providing a source of ammonia;
- (3) reacting ammonia with nitric acid to produce ammonium nitrate;
- (4) preparing a nitrate containing a first metal by reacting a compound containing the first metal with nitric acid or ammonium nitrate;
- (5) either:
  - 10 (a) preparing a nitrate containing a second metal by:
    - (i) contacting a compound containing the second metal with nitric acid; or
    - (ii) contacting a compound containing the second metal with ammonium nitrate; or
  - (b) providing a compound containing the second metal; and
- 15 (6) mixing the nitrate containing the first metal from step (4) with the nitrate containing the second metal or the compound containing the second metal from step (5) and ammonium hydroxide to form the LDH containing nitrate as an interlayer anion and ammonium nitrate.

2. A method as claimed in claim 1 further including the step of :

- (7) recovering the LDH and the ammonium nitrate from step (6).

3. A method as claimed in claim 1 or claim 2 wherein the source of nitric acid comprises a nitric acid plant or a nitric acid storage facility.

25 4. A method as claimed in any one of claims 1 to 3 wherein the source of ammonia is an ammonia plant for the production of ammonia or an ammonia storage facility.

5. A method as claimed in any one of the preceding claims wherein steps (1), (2) and (3) comprise process steps for producing ammonium nitrate in an ammonium nitrate plant.

6. A method as claimed in any one of claims 1 to 5 including preparing a nitrate containing the first metal by reacting a compound containing the first metal with nitric acid from step (1), providing an hydroxide containing the second metal, mixing the nitrate containing the first metal with the hydroxide containing the second metal and ammonium hydroxide to form the LDH and ammonium nitrate and separating the LDH and ammonium nitrate into a liquid phase containing the ammonium nitrate and a solid phase containing the LDH.

10 7. A method as claimed in claim 6 wherein the ammonium hydroxide is supplied from step (2) and the liquid phase containing ammonium nitrate is returned to step (3) or recovered for storage or sale.

15 8. A method as claimed in claim 6 or claim 7 wherein the first metal is magnesium and magnesium nitrate is formed by reacting one or more of magnesite, magnesia or magnesium hydroxide with nitric acid, and the second metal is aluminium and the hydroxide containing aluminium is  $\text{NaAl}(\text{OH})_4$ , and the step of forming the LDH and ammonium nitrate also forms sodium nitrate and the method further includes treating the liquid phase to remove sodium nitrate therefrom.

20 9. A method as claimed in claim 6 or claim 7 wherein the first metal is magnesium and magnesium nitrate is formed by reacting one or more of magnesite, magnesia or magnesium hydroxide with nitric acid, and the second metal is aluminium and the hydroxide containing aluminium is  $\text{Al}(\text{OH})_3$ .

10. A method as claimed in claim 8 or claim 9 wherein the hydroxide containing aluminium is derived from bauxite.

25 11. A method as claimed in any one of claims 1 to 5 including preparing a nitrate containing the first metal by reacting the compound containing the first metal with ammonium nitrate, preparing a nitrate containing the second metal by reacting a compound containing the second metal with nitric acid, mixing the nitrate containing the first metal with the nitrate containing the second metal and ammonium hydroxide to form the LDH and ammonium nitrate and separating the LDH and ammonium

nitrate into a liquid phase containing ammonium nitrate and a solid phase containing LDH.

12. A method as claimed in claim 11 wherein the compound containing the first metal is calcined magnesia and the step of forming the nitrate containing the first metal comprises reacting the calcined magnesia with ammonium nitrate to form magnesium nitrate and ammonium hydroxide and the compound containing the second metal is sodium aluminate or aluminium trihydroxide.

13. A method as claimed in any one of claims 1 to 5 including the steps of preparing a nitrate containing the first metal by contacting the compound containing the first metal with ammonium nitrate, preparing a nitrate containing the second metal by contacting the compound containing the second metal with ammonium nitrate, mixing the nitrate containing the first metal with the nitrate containing the second metal and ammonium hydroxide to form the LDH and ammonium nitrate, separating the LDH and ammonium nitrate into a liquid phase containing ammonium nitrate and a solid phase containing LDH and recycling the ammonium nitrate to step (2) or to the steps of preparing the nitrate of the first metal and/or preparing the nitrate of the second metal.

14. A method as claimed in any one of claims 1 to 5 wherein step 5(b) comprises supplying sodium aluminate provided from a pregnant Bayer liquor from a bauxite digestion plant.

15. A method as claimed in any one of claims 1 to 5 further including preparing the nitrate containing the first metal in step (4) by reacting the compound containing the first metal with ammonium nitrate.

16. A method as claimed in claim 15 wherein ammonium nitrate formed in step (6) is recycled to step (4) to produce more nitrate containing the first metal for LDH production.

17. A method as claimed in claim 15 or claim 16 wherein ammonia is also produced in step (4), and the ammonia is passed to step (6) or recycled to the source of ammonia in step (2).

18. A method as claimed in any one of claims 1 to 5 wherein step (5) includes producing a nitrate containing the second metal by contacting a compound containing the second metal with ammonium nitrate and ammonium nitrate produced in step (6) is returned to step (5).

5 19. A method as claimed in any one of claims 15 to 17 wherin step (5) includes producing a nitrate containing the second metal by contacting a compound containing the second metal with ammonium nitrate and ammonium nitrate produced in step (6) is returned to step (5) or returned to step (4) or returned to both step (4) and step (5).

10 20. A method as claimed in any one of the preceding claims wherein the fist metal is magnesium, the second metal is aluminium, the LDH is hydrotalcite and the hydrotalcite is formed by mixing aqueous solutions containing the first metal and the second metal and mixing with ammonium hydroxide to maintain a pH at about 9.5.

15 21. An integrated plant for producing ammonium nitrate and LDH containing nitrate as an interlayer anion including an ammonium nitrate plant for producing ammonium nitrate from nitric acid and ammonia, a first reactor for producing the LDH material by mixing a compound containing a first metal, a compound containing a second metal, ammonium hydroxide and one or both of nitric acid or ammonium nitrate, wherein at least part of one or more of the nitric acid, ammonium nitrate and ammonium hydroxide are provided from the ammonium nitrate plant and separation means for separating the LDH material and ammonium nitrate formed in the first reactor into a liquid phase containing ammonium nitrate and a solid phase containing LDH material.

20 22. A plant as claimed in claim 21 further including a second reactor for mixing a compound containing the first metal with either nitric acid or ammonium nitrate to produce a nitrate containing the first metal and first transfer means for transferring the nitrate containing the first metal from the second reactor to the first reactor.

25 23. A plant as claimed in claim 21 or claim 22 further including a third reactor for mixing a compound containing the second metal with nitric acid or ammonium nitrate to produce a nitrate containing the second metal and second transfer means for

transferring the nitrate containing the second metal from the third reactor to the first reactor.

24. A plant as claimed in claim 23 further including nitric acid transfer means for transferring nitric acid from the ammonium nitrate plant to the second reactor such that the compound containing the first metal and nitric acid react in the second reactor to form the nitrate containing the first metal.

25. A plant as claimed in claim 23 further including nitric acid transfer means for transferring nitric acid from the ammonium nitrate plant to the third reactor such that the compound containing the second metal and nitric acid react to form the nitrate containing the second metal.

26. A plant as claimed in claim 22 further including ammonium nitrate transfer means for transferring ammonium nitrate to the second reactor such that the ammonium nitrate reacts with the compound containing the first metal to form the nitrate containing the first metal and transfer means to transfer the nitrate containing the first metal from the second reactor to the first reactor.

27. A plant as claimed in claim 26 wherein reaction of the compound containing the first metal with the ammonium nitrate also forms ammonium hydroxide and the plant further includes ammonium hydroxide separation means for separating ammonium hydroxide from the nitrate containing the first metal and ammonium hydroxide transfer means for transferring the ammonium hydroxide to the ammonium nitrate plant.

28. A plant as claimed in claim 23 further including ammonium nitrate transfer means for transferring ammonium nitrate to the third reactor such that the ammonium nitrate reacts with the compound containing the second metal to form the nitrate containing the second metal and transfer means to transfer the nitrate containing the second metal from the third reactor to the first reactor.

29. A plant as claimed in claim 28 wherein reaction of the compound containing the second metal with the ammonium nitrate also forms ammonium hydroxide and the plant further includes ammonium hydroxide separation means for separating ammonium hydroxide from the nitrate containing the second metal and

ammonium hydroxide transfer means for transferring the ammonium hydroxide to the ammonium nitrate plant.

30. A plant as claimed in claim 21 or 22 further including ammonium nitrate transfer means for transferring ammonium nitrate formed in the first reactor to the ammonium nitrate plant or to ammonium nitrate storage.